



Research Article

Assessment of Fish Diversity and Weight-Length Analysis of Dominant Species in Haleji Lake District Thatta, Sindh, Pakistan

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Abstract | Assessment of fish diversity and weight-length analysis of dominant species in Haleji Lake, District Thatta Sindh, Pakistan was enumerated during September-June 2017-2019 accordingly. Total collection of fish in the studies was 1066 number and consists of 28 kinds related 11 families. Simpson's biodiversity index (1-D=0.927) shows that the surroundings of Haleji lake observed as low in terms of fish diversity, propagation and growth. Shannon- Weiner index (H) was used to compute richness and abundance from four locations. Highest richness and abundance were noted at site I richness (32%) abundance 429 and diversity index (DI) 0.927 correspondingly while lowest detected at site IV richness, 20% abundance 121 and diversity index (DI) was 0.87 accordingly. Three kinds of native carps like *Labeo rohita* (11.25%), *Cirrhinus mrigala* (10.88%), *Cirrhinus reba* (9.47%) and one species of each Clupiedae, *Gudusia chapra* (10.31) and Cichlidae, *Oreochromis mossambicus* (16.22%) were found to be leading (dominant) kinds throughout examination period and from sampling sites. Analysis of weight and length was accomplished for 5 leading fish kinds of carps and two other kinds throughout investigations. Examination of regression showed (b= values) healthier progress in all fish such as *Gudusia chapra* (b = 3.05), followed by *Cirrhinus mrigala* (b= 3.0), *Cirrhinus reba* (b = 2.98) *Labeo rohita* (b = 2.96) and *Oreochromis mossambicus* (b =2.96) all displayed perfect or near to perfect growth (b=3.0) throughout the study period as described thru following equations. $\log w = -1.96 + 3.05 \times \log l$ for *Gudusia chapra*, $\log w = -2.30 + 3.0 \times \log l$ for *Cirrhinus mrigala*, $\log w = -1.89 + 2.98 \times \log l$ for *Cirrhinus reba*, $\log w = -2.12 + 2.96 \times \log l$ for *Labeo rohita*, $\log w = -1.88 + 2.96 \times \log l$ for *Oreochromis mossambicus*. Further, it was recommended that three dominant carps and two other species displayed perfect (Ideal) growth in Haleji Lake, District Thatta, Sindh, Pakistan.

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Keywords | Fish diversity assessment, Weight-length analysis, Major carps, Haleji Lake, Thatta, Sindh, Pakistan



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Introduction

Haleji lake is placed at the distance of 10 KM from city of Thatta on way to Karachi, Sindh. It is filled through the canal termed as KB Feeder (Kalri-Baghar) arise from river Indus (IUCN, 2014). It was shaped through the association of two minor natural depressions namely Haleji and Makhdoom Ji Golai. It was renamed as Haleji lake during 1972 as man-made (artificial) depression. It also covered an area about 27.35 km. The depth of lake is varied from 6-8 meters (Lashari *et al.*, 2021). Haleji Lake is the manmade freshwater lake of Sindh was established to provide drinking water to Karachi city. Presently, lake provides an excellent habitat for not only support significant population of fish but declared as migratory birds' sanctuary as well. Fish diversity is extensively demarcated as variability and inconsistency of life on globe. The change and inconsistency are significant in providing important information that plays a vital role for the man hood (Shaikh *et al.*, 2018). As per Hashim *et al.* (2016) diversity of sweet water atmosphere establishes several censoriously indispensable elements of sphere, and richness of certain types which may rationally advance and linked with aquatic and earthly systems. Sweet water environment assessed as utmost endangered bionetworks at the moment across the sphere that denoted about 25% kinds (varieties) of vertebrates on globe (Baloch *et al.*, 2023). The deprivation of environment in freshwater biodiversity principally triggered by disintegration, induction of foreign fish kinds, pollution caused by industries, worldwide weather change, assault of native kinds/species and water alterations (Hashim *et al.*, 2016).

The purpose to analyses weight against length in given fish species supports to determine administration and conservational problems and to compute condition or wellbeing of fish (Hossain *et al.*, 2008; Lal *et al.*, 2023). Analysis of weight and length in modern fisheries research offer support to approximation of growth status, population structure, concerning existing and upcoming rates of reproduction and survival (Ahmed *et al.*, 2012; Vohra *et al.*, 2021). It used to discover indefinite weight from identified length and other way round (Baloch *et al.*, 2019). It also used to assess the welfare in relation to growth style, physiological condition, behavior of reproduction, seasonal deviations and food availability (Jamali *et al.*, 2018; Asadujjaman *et al.*, 2024). At the moment

little information is available on the fish diversity and weight-length analysis from Haleji Lake, District Thatta, Sindh (Lashari *et al.*, 2021). So, the current examinations were accomplished to discover the fish potential of Haleji lake for the raising of economically feasible fish kinds. The length-weight study reveals the positive allometric type of growth of experimental fish.

Materials and Methods

Procurement of testers

The testers of fish were acquired monthly from September-June during 2017-2019. Total 1066 (588 and 478 in summer and winter accordingly) varieties were arbitrarily taken from Haleji Lake, district Thatta. Sampled fish were obtained from the fishermen of the site via several nets with various meshes like hand (Hathjal), cast (Sotawajal), drag (Wahera) and gill (Laung) was applied for the catching of fish. Collected tester fish then secured with 10% formalin in fish carrying bags and carried to the research laboratory department of Fisheries and Aquatic Sciences, University of Sindh, Jamshoro for more examinations like dissection for the identification of sex, and documentation of fish up to species through diverse keys. Length was taken through measuring tape in cm and weight by using digital electronic balance in gms. Sampled testers were then taken out from formalin, cleaned and washed with water after that the diverse fish kinds classified and documented via various keys as recommended by Talwar and Jhingran (1991), existing literature and fish-base web-sites.

Estimation for the diversity analysis of fish

Estimation for the analysis of fish diversity, the Shannon Weiner index (H) was taken for the purpose to analyze richness of diverse kinds.

$$H = - \sum P_i \log_2 P_i$$

Where, H = Shannon – Weiner index Σ = Sum Species diversity was calculated following Shannon – Weiner index (H) which depends on both the number of species present and the abundance of each species.

ni= Number of individuals of each species in the sample.

$$d = S - 1 / \ln N$$

The S = indicated as no. of fish N= denoted as total

no. of each species of the sample

Weight-length analysis

In order to determine relationship between body length and weight, samples of fish were collected during September 2018 to August 2019 from the fishermen living in the sampling areas. A total of 415 fish specimen constituting five species of carps namely *Cirrhinus mrigala*, *Labeo rohita*, *Cirrhinus reba*, *Gudusia chapra* and *Oreochromis mossambicus* with size ranging from 10.1-65.0 cm. were selected. Data was analyzed through the formula $W=aL^b$ (LeCren, 1951; Ricker, 1973). According to them W =weight, L = length and analysis of condition was evaluated from the association of $K= 100W/L^3$ monthly basis. Analysis of variance (ANOVA) and Simpson's Biodiversity Index, $1/D$ were used to compare the data among samples.

Results and Discussion

Fish diversity

In the current examination (survey) from Haleji lake, district Thatta. Sindh during September-June 2017-2019. Total 1066 kinds of fish were documented and characterized into 07 orders, 11 families and 28 kinds. Three kinds of native carps like *Labeo rohita* (11.25%), *Cirrhinus mrigala* (10.88%), *Cirrhinus reba* (9.47%) and one species of each Clupiedae, *Gudusia chapra* (10.31) and Cichlidae, *Oreochromis mossambicus*

(16.22%) were found to be leading (dominant) kinds throughout examination period and from sampling sites and displayed at (Table 1). The Simpson's biodiversity index ($1-D = 0.927$) shows that the surroundings of Haleji lake seems as low in terms of fish diversity, propagation and growth.

Weight-length analysis

Association of weight against length of three dominant carps and two other fish kinds and their regression showed (b = values) healthier progress in all fish such as *Gudusia chapra* ($b = 3.05$), followed by *Cirrhinus mrigala* ($b = 3.0$), *Cirrhinus reba* ($b = 2.98$) *Labeo rohita* ($b = 2.96$) and *Oreochromis mossambicus* ($b = 2.96$) all displayed perfect or near to perfect growth ($b=3.0$) throughout the study period as described thru following equations.

$$\begin{aligned}\log w &= -1.96 + 3.05 \times \log l \text{ for } \textit{Gudusia chapra} \\ \log w &= -2.30 + 3.0 \times \log l \text{ for } \textit{Cirrhinus mrigala} \\ \log w &= -1.89 + 2.98 \times \log l \text{ for } \textit{Cirrhinus reba} \\ \log w &= -2.12 + 2.96 \times \log l \text{ for } \textit{Labeo rohita} \\ \log w &= -1.88 + 2.96 \times \log l \text{ for } \textit{Oreochromis} \\ &\quad \textit{mossambicus}\end{aligned}$$

To end, it was decided that three dominant carps and two other species displayed perfect (Ideal) growth in Haleji Lake, District Thatta, Sindh, Pakistan displayed at (Tables 2, 3, 4, 5 and 6).

Table 1: Fish biodiversity of Haleji Lake, district Thatta, Sindh, Pakistan.

S. No.	Fish species	Total (n*)	n-1	n (n-1)
1	<i>Labeo rohita</i>	120	119	14280
2	<i>Cirrhinus mrigala</i>	116	115	13340
3	<i>Cirrhinus reba</i>	101	100	10100
4	<i>Gudusia chapra</i>	110	109	11990
5	<i>Oreochromis mossambicus</i>	173	172	29756
6	<i>Labeo calbasu</i>	48	47	2256
7	<i>Aorichthyes oar</i>	45	44	1980
8	<i>Mystus seenghala</i>	53	52	2756
9	<i>Wallago attu</i>	43	42	1806
10	<i>Notopterus notopterus</i>	73	72	5256
11	<i>Channa striata</i>	78	77	6006
12	<i>Chanda rama</i>	41	40	1640
13	<i>Xenentodon cancella</i>	65	64	4160
Total		N** = 1066 N-1 = 1065 N (N-1) = 113529		$\Sigma n (n-1) = 105326$ $D^{***} = \Sigma n (n-1) / n (n-1) = 0.927$ 1-D = 0.073 1/D**** = 1.36

n =* number of species, N = **Total number of specimens, $1-D$ = *** Simpson's biodiversity index, $1/D$ = **** Simpson's reciprocal index.

Table 2: Relationship between total length and weight of *Labeo rohita* from Haleji Lake.

S. No	Length group (cm)	Length characteristics				Weight characteristics			
		Max	Min	Mean	SD	Max	Min	Mean	SD
1	20.1- 30.0	29	24.85	26.85 ^a	1.61	265	175	217 ^a	30.09
2	30.1-40.0	40	31.3	35.48 ^b	3.19	350	290	310.4 ^b	21.78
3	40.1-50.0	49.9	47.4	48.9 ^c	0.88	830	770	792 ^c	29.08
4	60.1-70.0	64	60.28	62.33 ^d	1.22	980	835	880 ^d	51.67

Different superscripts in each column indicate that values are significantly different ($P<0.05$).

Table 3: Relationship between total length and weight of *Cirrhinus mrigala* from Haleji lake, district Thatta, Sindh.

S. No	Length group (cm)	Length characteristics				Weight characteristics			
		Max	Min	Mean	SD	Max	Min	Mean	SD
1	30.1-35.0	35	30.2	32.2 ^a	1.92	375	260	325 ^a	12.27
2	35.1-40.0	40	35.98	37.96 ^b	1.42	400	360	380.3 ^b	13.30
3	40.1-45.0	45	40.2	42.86 ^c	1.60	465	410	430 ^c	12.02
4	45.1-50.0	49.98	46.5	48.5 ^d	1.30	485	433	450.5 ^d	15.41
5	50.1-55.0	55	51.5	53.7 ^e	1.21	575	450	500 ^e	14.10
6	55.1-60.0	60	59.99	60 ^f	0.04	685	620	650 ^f	14.73

Different superscripts in each column indicate that values are significantly different ($P<0.05$).

Table 4: Relationship between total length and weight of *Gudusia chapra* from Haleji Lake.

S. No	Length group (cm)	Length characteristics				Weight characteristics			
		Max	Min	Mean	SD	Max	Min	Mean	SD
1	10.1- 15.0	14.2	11.5	13.35 ^a	1.65	29.8	20.4	25.7 ^a	3.60
2	15.1-20.0	19.5	16.7	18.4 ^b	1.6	34.5	28.8	30.5 ^b	4.15
3	20.1-25.0	24.8	21.5	23.3 ^c	2.14	40.9	33.6	37.3 ^c	5.30

Different superscripts in each column indicate that values are significantly different ($P<0.05$).

Table 5: Relationship between total length and weight of *Cirrhinus reba* from Haleji Lake.

S. No	Length group (cm)	Length characteristics				Weight characteristics			
		Max	Min	Mean	SD	Max	Min	Mean	SD
1	10.1- 15.0	14.9	12.5	13.85 ^a	1.65	31.2	23.5	28.7 ^a	4.80
2	15.1-20.0	18.5	17.4	18.5 ^b	1.5	35.5	29.4	33.8 ^b	2.15
3	20.1-25.0	24.5	22.2	23.0 ^c	1.1	42.5	35.0	38.5 ^c	3.30
4	25.1-30.0	28.5	23.2	26.8 ^d	27.4	51.6	39.5	45.8 ^d	4.33

Different superscripts in each column indicate that values are significantly different ($P<0.05$).

Table 6: Relationship between total length and weight of *Oreochromis mossambicus* from Haleji Lake.

S. No	Length group (cm)	Length characteristics				Weight characteristics			
		Max	Min	Mean	SD	Max	Min	Mean	SD
1	10.1-15.0	13.5	11.2	12.5 ^a	1.65	33.5	28.2	28.7 ^a	3.60
2	15.1-20.0	19.5	16.2	17.3 ^b	1.8	34.2	28.5	33.8 ^b	2.10
3	20.1-25.0	23.8	21.5	22.5 ^c	1.1	41.4	36.8	38.5 ^c	3.50

Different superscripts in each column indicate that values are significantly different ($P<0.05$).

The investigation on the fish biodiversity in relation to factors related to the excellence of water from Haleji

Lake, District Thatta Sindh, Pakistan in relation to water quality parameters and its effects on fish diversity,

fish growth factors like length, weight and condition factor analysis to explore biology of significant and dominant fish species was accomplished from 2017-2019 accordingly.

In the current examination of fish diversity, total collection of fish in the studies was 1066 number and consists of 28 kinds related 11 families. Shannon-Weiner index (H) was used to compute richness and abundance from four locations. Highest richness and abundance were noted at site I richness (32%) abundance 429 and diversity index (DI) 0.91 correspondingly while lowest detected at site IV richness, 20% abundance 121 and diversity index (DI) was 0.75 accordingly in summer. Three kinds of native carps like, *Cirrhinus mrigala*, *Labeo rohita*, *Cirrhinus reba* and two other kinds *Gudusia chapra* and *Oreochromis mossambicus* were found as leading (dominant) kind species throughout examination period and from sampling sites. Alike tendency was also recorded in winter. Variety of investigators like [Mirza et al. \(2011\)](#) computed fish assortment from Jhelum River, Pakistan. Reported as river is productive and possess Shannon index values of 2.91 of fish kinds. They emphasized exotic fish are in leading kinds in contrast to native ones. Lastly, they also advised that the anthropogenic activities should be reduced immediately near the river. [Khan and Hassan \(2011\)](#) surveyed various dams for their fish biodiversity of district Karak KPK Pakistan and observed that *Cyprinidae* family was found in lead with the comparison of other fish, like *Channidae*, *Siluridae* and *Mastacembelidae*. [Vyas et al. \(2012\)](#) surveyed various natural water bodies and ghats for the assessment of fish potential of MP, India. Family *Cyprinidae* was dominant among the sampled fish, followed by *Ambassidae*. As per their findings that indices of diversity were found higher than the ghat. [Begum and Zehara \(2014\)](#) identified variety of fish and its assortment in Hub dam. They noted that family *Cyprinidae* of carp fish was main in comparison to other families like *Percidae*, *Siluridae* and *Osteoglossidae*. The poor representation of fish belongs to families like *Clupidae*, *Symbranchidae* and *Chirocephalid* was recorded and the richness value was obtained higher in April-May summer. [Hussain et al. \(2016\)](#) represents periodic dissimilarity, fish assortment and richness in pond bodies adjacent to Ghazi Ghat. Comparative richness calculated was (72.27 %) of cyprinids with other fish families. Carp displayed high rate of occurrence and varied seasonally. [Hashim](#)

[et al. \(2016\)](#) recorded fish potential of Sarawan Karez in Balochistan, they noted that *Cyprinidae* family as lead seconded by catfish with some new species from Karez. Lastly, they suggested that Karez fisheries should be promoted in Balochistan for the poverty alleviation and sustainable development of the province. [Wani and Gupta \(2015\)](#) surveyed Udaisagar reservoir for the potential of fisheries from India. It was noted that major native carps were lead fish kind (dominant) around (75%) of the total catch. Among the native carps *Catla catla* was most popular species in contrast to *Cirrhinus mrigala* and *Labeo rohita*. [Shaikh et al. \(2018\)](#) assessed fish diversity of downstream of River Indus, adjacent to Jamshoro and found family *Cyprinidae* as leading fish kinds throughout sampling. Tilapia and catfish were the second lead fish that was around (15%) of the catch. [Abro et al. \(2020\)](#) work out on the freshwater fish diversity of lower reach of River Indus, Pakistan. Findings of their studies revealed that family *Cyprinidae* was led fish seconded by *Siluridae* and *Percidae* that constituted (23%) in contrast to carps (62%) of the total catch round the year. [Baloch et al. \(2023\)](#) calculated the fish bio-diversity of Sonmiani lagoon, Balochistan and recorded 36 families, 68 genus and 91 species. They detected that index of assortment was (1-D= 0.223) and disclosed that lagoon of Sonmiani distinguished as low to support fish diversity. These observations and results are identical with the current survey.

Analysis of weight and length was accomplished for 3 leading fish kinds of carps and two other kinds throughout investigations from Haleji lake. Examination of regression showed (b = values) healthier progress in all fish such as *Gudusia chapra* (b = 3.05), followed by *Cirrhinus mrigala* (b= 3.0), *Labeo rohita* (b = 2.98) *Cirrhinus reba* (b = 2.96), *Oreochromis mossambicus* (b =2. 96) all displayed perfect or near to perfect growth (b=3.0) throughout the study period. Quite a good number of scholars such as [Laghari et al. \(2011\)](#) detected weight-length analysis in *Tilapia nilotica* from cemented ponds and stated that the growth of experimental fish displayed as positive allometric style as the regression co-efficient b values were found to be 2.87 in concrete pond near Hub, Balochistan. [Naem et al. \(2015\)](#) computed analysis of weight-length in *Pangasius* and collected 110 juvenile samples of 0.64 g in weight and 5.03 cm in length. The out-come was strong correlation with r-value 0.940 exhibited in LWR, and values of slope (b) 3.05, specified isometric growth pattern. [Anni et](#)

al. (2016) found that significant association of length and weight in *T. mossambicus* samples and suggested that the positive allometric growth. Computation of condition factor for all testers were 0.79 resulted as decent condition. Jamali et al. (2018) conveyed evidence of weight-length association in leading (dominant) carp fish kind in Keenjhar Lake, from 256 fish samples out of which *Cyprinus carpio* were 77 ranging from 33.7-37.4 cm, *Labeo rohita* were 75 ranging from 32.0-45.7cm, *Cirrhinus mrigala* was 45 ranging from 41.3-46.6 cm. In case of *Hypophthalmichthys molitrix* the total number was 33 ranging from 39.3-44.2 cm and 26 were *Catla catla* ranging from 33.7-44.9 cm, respectively. Values of regression among these fish detected as positive allometric style. Baloch et al. (2019) investigate length-weight analysis from Sonmiani Lagoon, Balochistan, they concluded that among the experimental leading fish kind 4 displayed regression below idyllic 3 and the *Acanthopagrus berda* with above 3. Vohra et al. (2021) assessed association of weight and length in carps with regards to cyclic changes in Kori Lake was assessed from 900 specimens of (*L. rohita*, *C. mrigala*, *C. carpio*, *C. catla* and *L.*). Their out-come of regression co-efficient values (b=) among the variables were 2.31, 2.39, 2.37, 2.31 and 2.32 accordingly, indicated as positive allometric style with satisfactory growth of carps.

Lal et al. (2023) measured carps leading (dominant) kinds of Nurri Lake for the association of weight against length examined from 1101 specimens out of which *Liza subviridis*, *Mugil cephalus*, *Acanthopagrus latus*, *Aulopaerea ocellata* and *Arius thalasinus* all were detected with positive allometric style. Conclude, that *Liza subviridis*, *Aulopaerea ocellata*, *Acanthopagrus latus*, and species, it was resolute that the *Mugil cephalus* was tremendously adjacent to being in best state (b= 2.92). The information furnished by the above-mentioned scholars supports the explanations of the current research from Haleji Lake.

Conclusions and Recommendations

Lastly, it was decided that the carp native indigenous and two other kinds distinguished to be most leading (dominant) fish kinds during whole examination. The length-weight study reveals the positive allometric type of growth of experimental fish. Finally, the Haleji lake strongly recommended for the raising of numerous fish kinds. The Government and non-

government organizations should come forward for the restoration of lake.

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Novelty Statement

The investigation of length and weight from the Haleji Lake, district Thatta, Sindh, Pakistan, the lake's ecosystem is excellent for future commercial species rearing and supports the fish potential to a significant extent.

Author's Contribution

Athar Mustafa Laghari: Performed the experiment and prepared initial draft of the manuscript.

Naeem Tariq Narejo: Designed and conceived the idea of this experiment.

Muhammad Hanif Chandio: Helped literature, manuscript reviewed, composed the document with data acquisition:

Faheem Saddar, Majida Perveen Narejo and Hamida Narejo: Helped in collection of fish and eggs samples for the research.

Muhammad Yunus Laghari, Munawar Lal and Urooj Imtiaz⁴: Helped in the relevant literature.

Ghulam Abbas and Shahnaz Rashid: Helped in manuscript reviewed, composed the document with data acquisition.

Conflict of interest

The authors have declared no conflict of interest.

References

- Abro, N.A. B. Waryani, N.T. Narejo, S. Ferrando, S.A. Abro, A.R. Abbasi, P.K. Lashari, M.Y. Laghari, G.Q. Jamali, G. Naz, M. Hussain and H. Hassan. 2020. Diversity of freshwater fish in the lower reach of Indus River, Sindh province section, Pakistan. Egypt. J. Aquatic Biol. Fish., 24(6): 2043-2065. <https://doi.org/10.21608/ejabf.2020.111114>
- Ahmed, Z.F., M.Y. Hossain and J. Ohtomi. 2012. Modeling the growth of silver hatchet chela *Chela cachius* (Cyprinidae) from the

- Old Brahmaputra River in Bangladesh using multiple functions. *Zool. Stud.*, **51**: 336-344.
- Anni, J., M.D. Askwith, A.P. Christena and A. Jeyaseeli. 2016. Length-weight relationship and condition factor of freshwater fish *Tilapia mosambica*. *J. Biol Innov.*, **5**: 758-763.
- Asadujjaman, M., M.Y. Hossain, M.F. Parvin, M.S. Sarmin, F. Nawer, W. Sabbir, M.A. Rahman, N.F. Ilah, M.J. Abedin, M.A. Samad and G. Kaushik. 2023. Stock's status of elongate glass-perchlet *Chanda nama* in the Ganges River (Bangladesh): Suggestions for future proper management. *Sarhad J. Agric.*, **40**(2): 275-2850. <https://doi.org/10.17582/journal.sja/2024/40.2.275.285>
- Baloch, N., N.T. Narejo, H. Kalhor, P.K. Lashari, H. Kalhor and F. Hashim. 2019. Studies on length- weight relationship and condition of fish from Sonmiani Balochistan, Pakistan. *Sindh Univ. Res. J.*, (Sci. Ser.), **51**(4): 507-512. <https://doi.org/10.26692/SURJ/2019.12.117>
- Baloch, N., N.T. Narejo, H. Narejo, M.F. Hassan, M.H. Chandio, F. Saddar, D.S. Thebo, G. Abbas and S. Rashid. 2023. Seasonal variation in aquatic biota in relation to physico-chemical parameters of sonmiani, Balochistan, Pakistan. *Sarhad J. Agric.*, **39**(1): 251-255. <https://doi.org/10.17582/journal.sja/2023/39.1.251.255>
- Begum, A. and N.Z. Afshee. 2014. Ichthyofaunal diversity of Hub reservoir Sindh, Balochistan, Pakistan. *Eur. Acad. Res.*, **2**(1): 341-353.
- Hashim, F., N.T. Narejo, P. Khan, S. Jalbani, G. Dastagir and P.K. Lashari. 2016. Fish potential from Karez Sarawan, Panjgoor Balochistan. *Sindh Univ. Res. J. (Sci. Ser.)*, **48**(4): 733-736.
- Hossain, M.Y., R. Islam, M.A. Hossain, M.A. Hossen, M.M. Rahman and J. Ohtomi. 2015. Threatened fishes of the world: *Cirrhinus reba* (Hamilton 1822) (Cypriniformes: Cyprinidae). *Croat. J. Fish. Ribarstvo*, **73**(1): 40-42. <https://doi.org/10.14798/73.1.786>
- Hossain, M.Y., P.M. Leunda, J. Ohtomi, Z.F. Ahmed, J. Oscoz and M. Miranda. 2008. Biological aspects of the Ganges River sprat *Corica soborna* (Clupeidae) in the Mathabhangra River (SW Bangladesh). *Cybiurn*, **32**(3): 241-246.
- Hussain, M.Z., A. Latif, W.A. Shahzadah, S. Hussain, R. Iqbal and M. Ali. 2016. Diversity, abundance and seasonal variations of fish community in lentic water bodies of Indus River at Ghazi Ghat, Pakistan. *Pak. J. Zool.*, **48**(1): 59-65.
- IUCN, 2014. IUCN red list of threatened species. Version 2014.3. IUCN 2014. IUCN Red List of Threatened Species. www.iucnredlist.org.
- Jamali, G.Q., N.T. Narejo, P. Khan, B. Waryani, G. Dastagir and S. Jalbani. 2018. Length-weight relationship and condition factor of five carp species from Keenjhar Lake, District Thatta, Sindh, Pakistan. *Sindh Univ. Res. J. (Sci. Ser.)*, **50**(4): 557-560. <https://doi.org/10.26692/sujo/2018.09.0090>
- Khan, M.A. and Z. Hasan. 2011. A preliminary survey of fish Fauna of Changhoz Dam, Karak, KPK, Pakistan. *World J. Fish Mar. Sci.*, **3**(5): 376-378.
- Laghari, M.Y., B.A. Dars and N.T. Narejo. 2011. Length-weight relationship of *Tilapia niloticus* in concrete pond of Habib ADM, Hub, Balochistan. *Sindh Univ. Res. J. (Sci. Ser.)*, **43**(1): 29-32.
- Lal, M., N.T. Narejo, M.H. Chandio, F. Saddar, H. Narejo, G. Dastagir, G. Abbas and S. Rashid. 2023. Analysis of length and weight of five dominant fish species from Nurri Lake District Badin, Sindh, Pakistan. *Sarhad J. Agric.*, **39**(2): 452-456. <https://doi.org/10.17582/journal.sja/2023/39.2.452.456>
- Lashari, H., N.T. Narejo, H. Kalhor, M.H. Chandio, F. Saddar and G. Dastagir. 2021. Environmental impact of water quality on fish production in Haleji Lake, District Thatta, Sindh, Pakistan. *Sindh Univ. Res. J. (Sci. Ser.)*, **53**(3): 205-208.
- LeCren, E.D., 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *J. Anim. Ecol.*, **20**(1): 201-219. <https://doi.org/10.2307/1540>
- Mirza, Z.S., M.R. Mirza, M.A. Mirza and A.Q.K. Sulehria. 2011. Ichthyofaunal diversity of the river Jhelum, Pakistan. *Biologia*, **57**(1 and 2): 23-32.
- Naeem, M., N.T. Narejo, A. Salam, S.A. Rasool, M. Khalid and A. Ishtiaq. 2015. Length- weight relationships of juvenile *Pangasius* with special reference to body size and condition factor. *Sindh Univ. Res. J. (Sci. Ser.)*, **47**(3): 523-526.
- Ricker, W.E., 1973. Computation and interpretation of biological statistic of fish population. *Bulletin. Fish. Res. Board Canada*, **191**: 1-382.

- Sheikh, M., M.Y. Laghari, P.K. Lashari, A.R. Khuharo and N.T. Narejo. 2018. Assessment of fish diversity of downstream Indus River, Sindh, Pakistan. *Pak. J. Zool. Suppl. Ser.*, 13: 184-190.
- Talwar, P.K. and A.G. Jhingran. 1991. *Inland fishes of India and adjacent countries*. Bombay: Oxford and IBH publishing CO, I-II. pp. 721-722, 332-333.
- Vohra, A.R., A.K. Khanzada, S.K. Khanzada and N.T. Narejo 2021. Length-weight relationship in terms of seasonal variation of carps from Kori Lake, Thatta Pakistan. *Ann. R.S.C.B.*, 25(1): 7241-7247.
- Vyas, V., D. Damde and V. Parashar. 2012. Fish biodiversity of Betwa River in Madhya Pradesh, India with special reference to a sacred ghat. *Int. J. Biodiv. Conserv.*, 4(2): 71-77.
- Wani, O.A. and U.S. Gupta. 2015. A study on Ichthyo faunal diversity of Sagar Lake, Madhya Pradesh, India. *Int. J. Biodiv. Conserv.*, 7(3): 126-129. <https://doi.org/10.5897/IJBC2014.0800>